

## RECYCLING WASTE-PAPER

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## ABSTRACT

Perhaps 80% of papermaking energy is expended in chemical pulping of vegetable cellulose, a natural polymer. Commercial supplies of wood, bagasse, cotton and flax are valued as "renewable resources" and "bio-mass" assets; however, few enterprises will salvage waste-paper and cardboard from their "trash." A basic experiment in the Materials Lab uses simple equipment to make crude handsheets. Students learn to classify "secondary fibers," identify "contraries," and estimate earnings.<sup>1</sup>

## INTRODUCTION

The U.S. still has 70% of those forests existing at Columbus'time, and about 50% of New York State is forest. Such vegetation is a prime national resource, a renewable raw-material for lumber, pulp, paper, plastics, and fuel. These industries represent major job-opportunities for mechanical technologists in production, process and maintenance. Yet, materials labs tend to neglect non-metals, especially common cellulose.

Pulp and paper production requires vast amounts of air, energy and water. Surging demands threaten to outstrip our plantations or degrade our environment, despite ingenious genetics and fiber conservation cited by ecologists.<sup>2</sup> Paper consumption, now estimated at 100-million annual tonnes, may reduce today's forests from 9.7 square meters per person to 7.7 (80%) by the year 2000.

Solid wastes are about 50% paper, increasing three times faster than U.S. population. Overcrowded dumps and smoky incinerators are now unacceptable. Most recycling involves only "pre-consumer" waste (mill-broke, rejects, trim) and comprises only 25% of "consumer-products" paper. The challenge is to salvage "post-consumer" waste.<sup>3</sup> The public should be educated and motivated to segregate marketable grades and to accept subsequent products.<sup>4</sup> Meantime, technologists can be trained to promote recycling by utilizing available and inexpensive equipment.

## TERMS

A different pulp and paper vocabulary emerges and new properties are introduced. Waste paper is "secondary-fibre". Color is specified by hue-depth-brightness, with metamerism from light-heat-humidity. Fast means permanent. Wires and felts are machine-clothing, and white-water is recycled machine-drainage. Fines are fiber particles, and broke is sheet-scrap. Converting is subsequent processing. Glassine is film from hard calendering. Fiber is floc, staple, fibrid, fibril, and tow. Non-wovens are formed on cylinders and fourdriniers.

Couching and picking affect sheet morphology. Deinking and bleaching affect secondary-fiber's softness and tenacity. MIT-fold (fatigue endurance), Elmendorf (impact tear propagation), Mullen (burst strength), Patterson (puncture), Taber (sheet stiffness), Finch (edge-tear), and Canadian Std. Freeness (pulp drainage) are properties. Measurements include caliper (thickness), basis weight (density as U.S. lb/ream), denier (grams/9000 m of yarn), sheet appearance (holes, feel, smoothness, drape), and absorbance (wicking).<sup>5</sup>

## PAPER GRADES

Pulps are classified by manufacturing process, timber source, or color:

1. Sulfite - made with sodium or calcium bisulfite; needs clean-up of plant waters; expensive and soft.
2. Sulfate (Kraft) - made with sodium sulfide and hydroxide; needs air cleanup; strong and cheap.
3. Soda - made with sodium hydroxide; cheaper than sulfite.
4. Semi Chemical - partial digestion and steam expansion.
5. Mechanical Groundwood - sawdust or wood flour; weakest, cheapest, harshest.<sup>6,7</sup>

Timbers are hardwood (deciduous; harsher, cheaper) or softwood (coniferous, evergreen; softer, costly) from the North (cold, slow growth; thin, supple fibers) or from the South (fast growth; thick, harsh fibers).

Colors are white (fully bleached), tan (semi-bleached) or brown (unbleached). Bleaching enhances softness, hurts strength.

Prices of virgin pulp range from \$300-\$800 per short ton (+1.1023 for metric ton), compared to recycled fibers of \$30-\$300. A typical mill using \$2,000,000 of pulp/month could save \$100,000/month with 25% recycled "secondary fiber" priced only 20% less. Some cardboard plants run 100% recycled boxes, bought from local stores and scrap dealers. This is big business.<sup>8</sup>

## PROCEDURE

In the mills, baled pulp and paper are hydrated and defibered to make "handsheets" for quality control tests, according to TAPPI Std. T-200. The conventional agitators (Valley® Beater; British Std.® Disintegrator) often take several hours. However, a Waring Blendor® takes 30-60 seconds, without presoaking! Blending involves intense fluid-shear in a 4-lobed canister, as 4-vortexes impinge. Thus, fiber clumps are unrolled rather than chopped to "fines" by impeller-blades.

Commercial labs make handsheets with vacuum-boxes (Valley® sheet mold) and steam-radiators (Williams® sheet-dryer).<sup>9</sup> Waste-paper dealers use conventional lab-filtration setups (Ehrlenmeyer flask, with Büchner funnel and filter-paper) requiring a vacuum pump or eductor nozzle (run tapwater to sewer).<sup>10</sup> However, the pocket-sized "scoop and press" (Ciba-Geigy® color sampler) can make 8 cm dia. sheets, quickly and easily. Thinner sheets are made by diluting the pulp-slurry

consistency. In a pinch, use a flat-bottomed strainer or evaporate a jar of slurry to leave a fiber-sheet.

A typical recipe is a) Tear a tabcard (83 x 187 x 0.02 mm thick) into postage-stamp pieces; b) Drop into Blendor®, with 50 ml. water(23°C); c) Blend at low-speed for 30 sec; d) Pour slurry into shallow bowl; e) Look for complete defibering of "pulp-bundles"; f) Scoop and press to de-water the "pulp-patty" and lift the new sheet, which sticks to the press rather than the screen-knuckles; g) Dry the handsheet on hot-plate or electric-griddle; h) Use a lid to keep the sheet flat and aid inspection; i) View thick sheets by reflected light, to find "contaminants" (flakes of clay, specks of foil or film); j) Thin sheets are viewed by transmitted light, to find buried "contraries" (wet-strength clumps of fibers); k) Tiny balls of pernicious latex or tar are probed with a needle, pulling a fine filament like a spider web; l) As required, dyes and wet-strength can be tested for "bleachability;" m) Pulping time may be reduced, using hotter water.

### CONCLUSION

Students should be instructed to write formal proposals to management, detailing each step of a careful investigation:

a) consistent monthly tonnage of available waste-paper, by grade; b) location and cost of baler; c) selection and cost of fiber-collectors and equipment-operators; d) selection of a reliable dealer and determination of minimum fiber price; e) method of shipment, ensuring plant security; f) estimated earnings and equipment payoff, including savings of trash-service. Busy bosses ignore casual suggestions.

### RECYCLE SAMPLES 11,12

1. Newspapers - plain, printed, colored.
2. Magazines - pages only; no covers or staples; no coatings, clay or latex.
3. Envelopes and Stationery - white, colored, unbleached; no glassine windows or latex labels.
4. Creped wadding - facial, bathroom, towel, napkin tissues; white, pastel, deep-dyed; plain and wet-strength.
5. Computer scrap - printouts or tabcards; no carbons; white, pastel.
6. Kraft sulfate - bags, wrappers; unbleached, semi-bleached.
7. Boxboard - linerboard, corrugate; unbleached, semi-bleached; grey, brown.

### EQUIPMENT AND SUPPLIES

1. Waring Blendor® - 120 v, 60 Hz, stainless steel canister.
  - a. Commercial Model CB-4 (TMI#52-4-2), 1 gal capacity (3.79 litres), 14,000-19,000 rpm, approved by Canadian Standards Association...\$700.

- b. Model 31-BL-92, 1 qt capacity (.95 litre)  
2-speed.....\$100.
- 2. Sunbeam Griddle® - 120 v, 60 Hz
  - a. "M'sieur Crepe," cat.#30-10, 750 W, with thermostat control  
and skillet lid.....\$ 20.
  - b. Sandwich grill or frypan.....\$ 20 - 40.
  - c. Laboratory hot-plate.....\$ 70.
- 3. Ciba-Geigy® Scoop and Press - stainless steel pans, nested.
  - a. Scoop approx. 8 cm I.D. x 2.2 cm depth, with wire screen  
on bottom (80-mesh).
  - b. Press approx. 7.5 cm O.D. x 2.5 cm depth, with solid bottom  
(deep-drawn).
- 4. Weigh Scale.
  - a. Ohaus Dial-a-Gram® balance, 310-g  
capacity.....\$100.
  - b. Standard postal scale (oz, g).....\$ 10.
  - c. Regular dietitian's scale (oz, g).....\$ 20.
- 5. Coffee pot, with thermostat control.....\$ 20.
- 6. Containers (glass or plastic).
  - a. Graduated cylinder or flask (100 - 1,000 ml).
  - b. Battery jars or cut jugs (2-4 litre size).
- 7. Bleaches.
  - a. Hydrogen peroxide (3.0% H<sub>2</sub>O<sub>2</sub>).
  - b. Sodium hypochlorite (5.25% NaOCl).
- 8. Dissecting needle (biology probe).
- 9. Spatula (pallet-knife).

#### ABBREVIATIONS

- APPA - American Paper and Pulp Association, New York, NY.
- API - American Paper Institute, Inc., 260 Madison Ave., New York,  
NY 10016.
- EE - Environmental Educators, Inc., 1621 Connecticut Ave., NW,  
Washington, DC 20009.
- EPA - Environmental Protection Agency, Washington, DC.
- NARI - National Association of Recycling Industries, Paper Stock  
Div., 330 Madison Ave., New York, NY 10017.
- NCRR - National Center for Resource Recovery, 1211 Connecticut Ave.,  
NW, Washington, DC 20036.

- TAPPI - Technical Association of the Pulp and Paper Industry,  
1 Dunwoody Park, Atlanta, GA 30338.
- TMI - Testing Machines, Inc., 400 Bayview Ave., Amityville, LI.,  
NY 11701.

Prefixes - Centi (c), milli (m), page (p).

Ream - Specific number of standard-size sheets; standard area  
varies with paper type.

Units - Gallon (4 quarts, 3.785 litres); gram (g); litre (l);  
metre (m); mil (0.001 inch); ounce (oz) Avoirdupois  
(28.35 g).

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